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ABSTRACT

Contained is a documentary of a comprehensive curricular/career model program at Mills College designed to help women enter scientific and technical fields. A series of vignettes illustrating key aspects of the program philosophy and methods is presented. Various viewpoints and experiences are related by women of different ages, ethnic backgrounds, levels of math preparation, and career aspirations in order to demonstrate that women can be motivated to enter nontraditional fields. Many elements of the program can be adapted for use at other educational levels and types of institutions to meet the needs of a variety of students. (Author/RE)

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Count Me In: Educating Women for Science and Math

Videotape Documentary and Brochure

Mills College, Oakland, California 94613

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Produced by Mills College under a grant from the U.S. Department of Health, Education, and Welfare, Office of Education, under the auspices of the Women's Educational Equity Act. Opinions expressed herein do not necessarily reflect the position or policy of the Office of Education or the Department, and no official endorsement should be inferred.

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INTRODUCTION

"Count Me In" is a 30-minute, black-and-white videotape documentary of a comprehensive curricular/career model program at Mills College designed to help women enter scientific and technical fields. A series of vignettes illustrating key aspects of the program philosophy and methods is presented. Various viewpoints and experiences are related by women of different ages, ethnic backgrounds, levels of math preparation, and career aspirations in order to demonstrate that women can be motivated to enter nontraditional fields. Many elements of the program can be adapted for use at other educational levels and types of institutions to meet the needs of a variety of students.

Since "Count Me In" is a documentary of a collegiate program, the primary target audience is at the college level: entering and reentering college women, and faculty and staff of mathematics and science departments and career and women's centers. In addition, the tape is appropriate for high school teachers, counselors, and administrators, as well as some upper level high school students and parents. It is anticipated that the tape will be used as a springboard for classroom or workshop discussions on nontraditional career opportunities for women, on the importance of mathematics studies for entering these fields, and on ways to increase the participation of women in mathematics courses and math-based fields.

It is hoped that the tape will help:

- stimulate interest in this area;
- encourage young women to keep their career options open by continuing their math studies;
- give concrete examples of methods that can be adapted to suit the needs of a variety of educational institutions.

"Count Me In" was produced on an extremely limited budget. Additional and more adequate funding has been granted to Mills College by the WEEA program to produce two color films, each 15 minutes long. One will be specifically for high school and entering college women, the other for professionals--teachers, counselors, school administrators--with the purpose of encouraging young women to consider technical studies and fields. Although "Count Me In" was intended primarily as a documentary of a specific program, it is also viewed as a pilot for the new films. Therefore, we welcome hearing audience reactions to this tape.

TAPE EPILOGUE (FALL 1977)

Sara's (T.A.) surprise at reading about a particle discovered in a balloon, (". . . and I didn't know anything about it") sparked her interest in science and her return to college at the age of 20. Thus, although she

was a music major at Mills, Sara also managed to take math and physics courses nearly each semester, participate in the math program as a T.A. (in the tape she knowingly tells her calculus workshop, "this rule will be firmly implanted in your brain--soon"), and do some independent study on the relationship between mathematics and the arts. Sara is now a graduate student in arts administration.

Claudia (premed student) always wanted to become a physician. Although her parents were both architects, she did not think she could "hack the discrimination she heard [her] mother talking about," and so she became a nurse instead. After attending a conference, "Educating Women for Science: A Continuous Spectrum," held at Mills in the spring of 1976, Claudia decided to return to college to complete the necessary math and science requirements for medical school. In the tape we see Claudia in Sara's calculus workshop. Claudia has now taken her MCATs (Medical College Admissions Tests) and is presently applying to medical schools.

Janet (undeclared major) had only two years of math in high school and less than a year of math in college. She started off at the "tail end" of the calculus class. She attended every workshop section she could manage and worked incredibly hard. Her efforts were rewarded. By the end of the year, Janet had acquired a deep understanding of the calculus and received an A- for the course. She is on leave this year doing missionary work for her church in Central America.

When *Terri* (T.A.) entered college, she thought she would become a drama major. During her sophomore year, she kept hearing about the math program and decided to enroll in precalculus to satisfy her curiosity. She "loved it" and decided to continue on into calculus. Terri then became a teaching assistant for a precalculus workshop. This experience increased her confidence further: "I discovered it was all right not to know all the answers." During her junior year, she became a math major. Terri then took an extra heavy math course load in order to complete her major requirements, and did not have time to be a T.A. again.

Jennifer (IBM intern) switched from premed to preengineering when she became fascinated with the possibilities of applying engineering techniques to medical problems (e.g., by designing artificial limbs). Over the past several years she has acquired considerable technical experience both by participating in the intern program and by taking summer jobs in engineering firms. Jennifer has now enrolled in engineering school (majoring in electrical engineering, with a possible emphasis in bioengineering) under Mills's dual-degree program.

Although *Geri* (NASA-Ames intern) now exudes a tremendous amount of scientific and technical self-assurance and sophistication, when she was in high school she believed that "girls shouldn't take math." In college she had to enter mathematics through the precalculus route. She majored in both chemistry and music and is now in medical school.

PROFILE OF MILLS COLLEGE

Mills College, the oldest nonsectarian college for women in the West, has for more than a century been a leader in liberal arts education for women, with a strong emphasis on the fine arts and humanities. Traditionally, the curriculum was not directed toward specific career preparation. In recent years, however, Mills has led the movement for educational and professional equity for women by developing strong career-oriented programs in the sciences, mathematics, c mputer sciences, management, and related fields.

Mills is a small residential college with a ratio of faculty to students of 13:1. Although the student body is small, there is a great deal of diversity. In 1976-77, Mills had an undergraduate population of 850 students and a graduate population of 150 students. Ethnic minorities, exclusive of foreign students, comprise approximately 22 percent of the undergraduate population. Approximately 15 percent of the undergraduates (about 125 students) are reentry women. Over half of the graduating seniors in 1977 indicated that they expect to hold full-time jobs immediately after graduating; over one-third have applied to graduate schools for 1977-78.

THE MILLS WOMEN IN SCIENCE PROGRAM

The Women's Educational Equity Act has recognized that subtle discrimination in education has resulted from stereotypic thinking and assumptions about sex-appropriate fields of study. As a result of these attitudes, many women have failed to pursue important basic studies in mathematics and the sciences, have been provided little opportunity for successful reentry into a technical curriculum, and as a consequence have been unable to compete in a job market where technical training is the "critical filter" for an increasing number of fields.[1]

In response to this situation, a comprehensive Women in Science program was established at Mills College in 1974 with the aim of providing access for women into scientific and technical studies and careers. This program has been developed, refined, and expanded with assistance from various agencies, including the Women's Educational Equity Act Program.[2] The idea

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[1] See, e.g., Lucy Sells, "High School Mathematics as the Critical Filter in the Job Market," in *Developing Opportunities for Minorities in Graduate Education*, Proceedings of the Conference on Minority Graduate Education, University of California, May 11-12, 1973, pp. 37-39; and John Ernest, *Mathematics and Sex*, Santa Barbara, Calif.: Mathematics Department, University of California, Santa Barbara 1976.

[2] This program was initially funded in part by a grant from the San Francisco Foundation. Additional support has been provided by IBM, the National Science Foundation, Xerox, and the Educational Foundation of America.

has been to create an environment where it is as natural and possible for women to study and consider careers in mathematics and the sciences as it has been in the humanities and the arts.

A key premise of the Mills program is that quick change in attitudes, aspirations, and capabilities is possible, and that positive experiences "doing it" can make the difference. Hence, the program is geared to getting students into a substantive mathematics curriculum quickly, and to providing students (even the most "math anxious") opportunities to become actively involved in peer teaching and industrial research projects. The program has a variety of interdependent components that involve coordinating career guidance and activities with the academic program. The main components are described below.

Stimulating Interest and Motivation and Providing Career Information

A mini-brochure describing the program and containing self-placement quizzes is distributed to students at registration in the beginning of the year. Special orientation sessions are held to discuss the importance of mathematics for various careers and the different routes into the mathematics curriculum. Well-publicized events are sponsored jointly by the Center for Career Planning and the Department of Mathematics and Computer Science. These events include audio-visual presentations, panel discussions with women scientists and engineers (who serve as important role models and potential mentors and contacts), and field trips to local corporations and research facilities.

Providing Quick Access into the Mathematics Curriculum

There are various entry routes into the mathematics curriculum: e.g., computer programming, mathematical modeling and statistics, precalculus and calculus. The Mills program puts particular emphasis on the precalculus/calculus route for several reasons. For one, calculus is a major "critical filter" in the job market: it is the prerequisite for studying and entering careers in the sciences, engineering, architecture, and business, as well as for advanced and more technical work in the social sciences (e.g., in economics and sociology). For another, calculus is an important component of a liberal arts education: the development and application of the calculus have been intimately connected with the development and growth of modern technology and our culture and society. Further, calculus is implicitly associated with college mathematics: a student who has taken calculus rightfully feels she has taken a real math course and knows she can go ahead in the field if she so chooses.

The precalculus course is specifically designed to prepare students (regardless of background) in one semester for a calculus sequence. This is done by streamlining the usual college algebra course to include mainly material directly related to calculus (e.g., graphing the elementary functions); eliminating the remedial aspects (which would just recall negative

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COUNT ME IN:

Educating Women For Science And Math

Videotape Documentary Brochure Mills College

Women's Educational Equity Act Program
U.S. Department of Health, Education, and Welfare
Office of Education

past experiences) while introducing more advanced, and therefore new, interesting, and challenging concepts and points of view from calculus (e.g., notions of slope, rate of change, limit, continuity, smoothness); and stressing visualization and the development of conceptual skills (by learning to ask relevant questions, for example, about symmetry, periodicity, growth properties, density). The course is augmented by a support structure of small peer-taught workshops where students get help in developing supplemental computational and algebraic skills.

This course is necessarily an intensive (five-day-a-week) program. Three hours per week are spent developing the conceptual aspects in class lectures taught by a regular instructor. Two hours are spent developing the computational aspects in small workshops taught by undergraduate students, not necessarily math majors. These undergraduate teaching assistants, or T.A.s as they are called, observe weekly demonstration workshops conducted by the instructor. In addition, auxiliary peer-taught workshops are offered to students in the calculus sequence, in order to provide continuing support--especially to students who have only recently embarked (or reembarked) on their mathematical training and do not have years of solid grounding or positive experiences behind them.

Providing Career Preparation and Access

One aspect of this effort is to increase the applicability of the mathematics curriculum by developing interdisciplinary courses (e.g., Mathe-

matical Modeling for the Social Sciences) and by introducing applications components into standard courses. Thus, knowledge of applications, along with knowledge of career opportunities, makes course work more relevant and helps motivate further study. Another aspect is the provision of concrete and meaningful experiences that help students develop the self-confidence and positive self-images needed to view many options as truly feasible. One means is the peer-teaching program. Another is the seminar program where students present technical talks. Still another approach is the intern program, which provides students with early career experiences through supervised work in "real world" job situations in industry or research centers on a part-time basis during the school year or for one or two months during the summer. This kind of experience is particularly important for young women who have had little or no opportunity for involvement with technical areas of the working world. In addition, dual-degree engineering programs with the University of California at Berkeley, Stanford University, and Boston University provide institutional access routes into engineering programs for Mills students.

PROGRAM EVALUATION

This program has been extremely successful in terms of its goal of increasing the participation of women in technical studies and fields. In the three years since the program began, enrollments in precalculus have

tripled (from 27 to 78) and total enrollments in regular mathematics and computer science courses have doubled (from 331 to 661). In addition, enrollments are increasing in higher level math courses (e.g., enrollments in differential equations tripled last year, from 8 to 25). Given a steady total college student population size of 850 undergraduates (plus 150 graduates), these increases are very significant and, indeed, far exceed national norms. (For example, according to a recent report of the Conference Board of the Mathematical Sciences,[3] during the years 1970-75, enrollments in precalculus courses in college and university math departments increased only 12 percent, while upper level enrollments in mathematics were down 32 percent). A remarkable fact is that enrollments in mathematics and computer science courses at Mills are now the second largest on campus--just slightly below enrollments in English courses.

About 30 students have participated in technical internships; 21 of these students have been placed at IBM in San Jose. Dr. J. P. Jacob of IBM has written to the National Research Council's Committee on Applied Mathematics Training, which is considering the Mills intern program as a model for other undergraduate mathematics programs, that "the successes achieved by the Mills students were beyond our best possible expectations. They range from contributions to research papers to the writing of instruction

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[3] *Undergraduate Mathematical Sciences in Universities, Four-Year Colleges, and Two-Year Colleges, 1975-1976*, Volume V of the Report of the CBMS Survey Committee.

manuals for the use of our special interactive systems. . . . By all measures we can think of, IBM considers the internship program a great success."

Preengineering is now one of the fastest growing options on campus; ten students have gone on to engineering schools. Thirteen students were placed in technical or engineering-related jobs this past summer. This contrasts with the situation less than ten years ago, when an informal survey showed that there was "little likelihood that Mills students would wish to pursue engineering." In addition, a group of about 25 students have formed a Math/Computer Science/Engineering Club, which sponsors speakers, films, tutoring projects, and science fairs; 15 students are helping to install a new computer center on campus (as part of a new NSF-funded project to increase computer literacy on campus). These developments are quite unusual at a women's college.

Mills has developed a national reputation as a leader in the area of mathematics education for women and in innovative mathematics education in general. The directors have been invited to discuss the program at numerous national professional meetings. Over 500 requests for information have been received from students, parents, teachers, administrators, and directors of special programs. Virtually every article or news story on women in mathematics discusses the Mills program.[4]

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[4]A formal evaluation of various components of the Mills programs is being prepared by Drs. Ruth Cronkite, Lynne Dobrofsky, and Elizabeth Scott.

ONGOING AND FUTURE PROGRAMS

Computer Literacy Project at Mills

During the next three years (1977-80), development in the computer science area will parallel the past development of the mathematics program. The goal is to provide 85 to 90 percent of Mills students with some direct computer experience before they graduate. A grant from the National Science Foundation will provide a small computer center with terminals at various campus locations, development of a general computer literacy program, integration of computer techniques into certain math, science, and social science courses, and development of advanced courses for the computer science major.

San Francisco Bay Area Women in Science Network

As a natural adjunct to the Women in Science program, Mills has been involved in the formation of the San Francisco Bay Area Women in Science Network. The Network is a unique cooperative effort undertaken by scientists, mathematicians, technicians, and educators from 30 colleges and universities, 15 school districts, and a number of corporations, government agencies, and foundations. The goal of the Network is to increase young women's participation in mathematical studies and to motivate them to enter careers in science and technology. Network members have jointly sponsored conferences and workshops for faculty, counselors, parents,

and students from all educational levels, and have also developed new academic and career planning programs.

Several Network conferences have been held on the Mills campus: "Educating Women for Science: A Continuous Spectrum," a conference for scientists, educators, and counselors; and "Expanding Your Horizons" and "Women in Science and Technology," conferences for high school students. In addition, Mills sponsored an NSF-funded regional two-day Women in Science career workshop last spring for freshman and sophomore college women with a goal of forming an "old girls" network of contacts for these students.

Although conferences have been directed to different audience levels, they have had two key features in common. The first is to stimulate interest and to provide career information and role models. The second is to provide positive concrete experiences in doing math and science.

A typical student-oriented conference day might start with a keynote speaker, then a round-table discussion with several women working in the scientific professions discussing the challenges and problems of their work and lives. For the rest of the morning, students attend math and science workshops centering on "hands-on" activities and experiments. For example, one group might observe animal behavior by constructing mazes for rats, while another may use topological puzzles or computer terminals to test problem-solving strategies. Advanced students participate in

seminars on math and science research topics. While the students are in workshops and seminars, parents, teachers, and counselors who have accompanied them meet with representatives from local colleges and universities to discuss scholarship opportunities, entrance requirements, and ways to encourage young women to pursue their math and science interests.

After lunch, participants choose from a variety of career workshops in which they are able to talk to women working in research, industry, and higher education in a more intimate setting about the opportunities for women in science. A reception for all participants closes the day's events.

Responses to the conferences have been very enthusiastic. For example, evaluation forms completed by the young women included comments such as this one from a high school student:

> It was very good for me to see so many professional women in what I usually think of as careers that are totally male. It changes my opinion of that career at a much deeper level than if someone had just said to me, "Yes, it is possible for women to go into that field." To see is to believe.

And this comment from a college student:

> It proved invaluable all around--I became informed, I met professional women after whom I may model my career steps,

> I met other women in my interest area, and feel as though I've been stimulated, encouraged, excited, motivated and greatly thrilled by the experiences of the last day and a half. Mills was beautiful--the conference facilities exceptional--I have no suggestions except perhaps to organize more opportunities specifically for the mixing of professional women and students in their fields. Having friendships, support, connections, leads, whatever--with professional women is something every other woman can benefit from. THANKS!

A recent letter from a participant in a conference last year gives some idea of the lasting effect:

> During the summer I did quite a lot of thinking about what career I might like to pursue and I reevaluated my goals and expectations. In doing this, I found myself thinking back often on the Women in Science Conference, and I know that having attended the conference has helped me out enormously. Also, hearing from you now, months after the conference, has really kept me in touch with my feelings and my love for mathematics. Thanks so much!

Activities of the Women in Science Network have reached the following audiences (approximate numbers):

- 1500 girls from grades 7-12 have participated in conferences and workshops.
- 550 elementary school girls have attended classes and workshops at the Lawrence Hall of Science, University of California, Berkeley.
- 600 college women have participated in conferences and programs.
- 800 educators (teachers, counselors, and administrators) and scientists have attended conferences and programs.
- 150 parents have attended programs addressed especially to them.

In addition, over 400 Network members have volunteered time and services as planners, speakers, panelists, workshop leaders, and liaison persons for various events.

Mills has received a second WEEA grant, a major portion of which is designed for Network activities: conferences, a handbook on student organization, and production of two films, one for students and one for teachers and counselors. Under this grant, four conferences for high school students were held on February 4, 1978 in different regions of the Bay Area: the Peninsula, San Francisco, Marin County, and the East Bay. Approximately 2000 high school students attended the conferences.

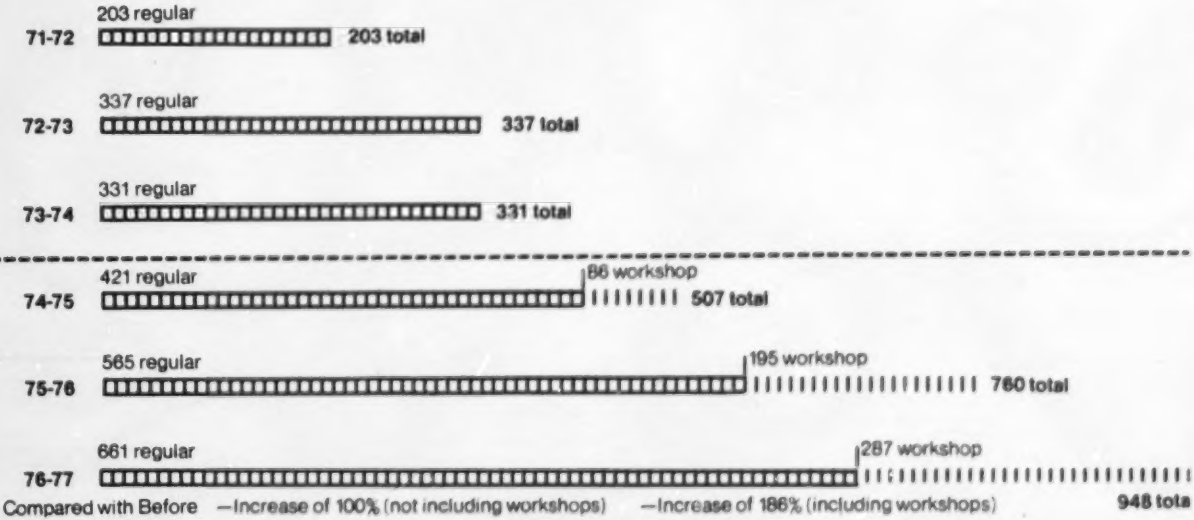
THE CONSORTIUM

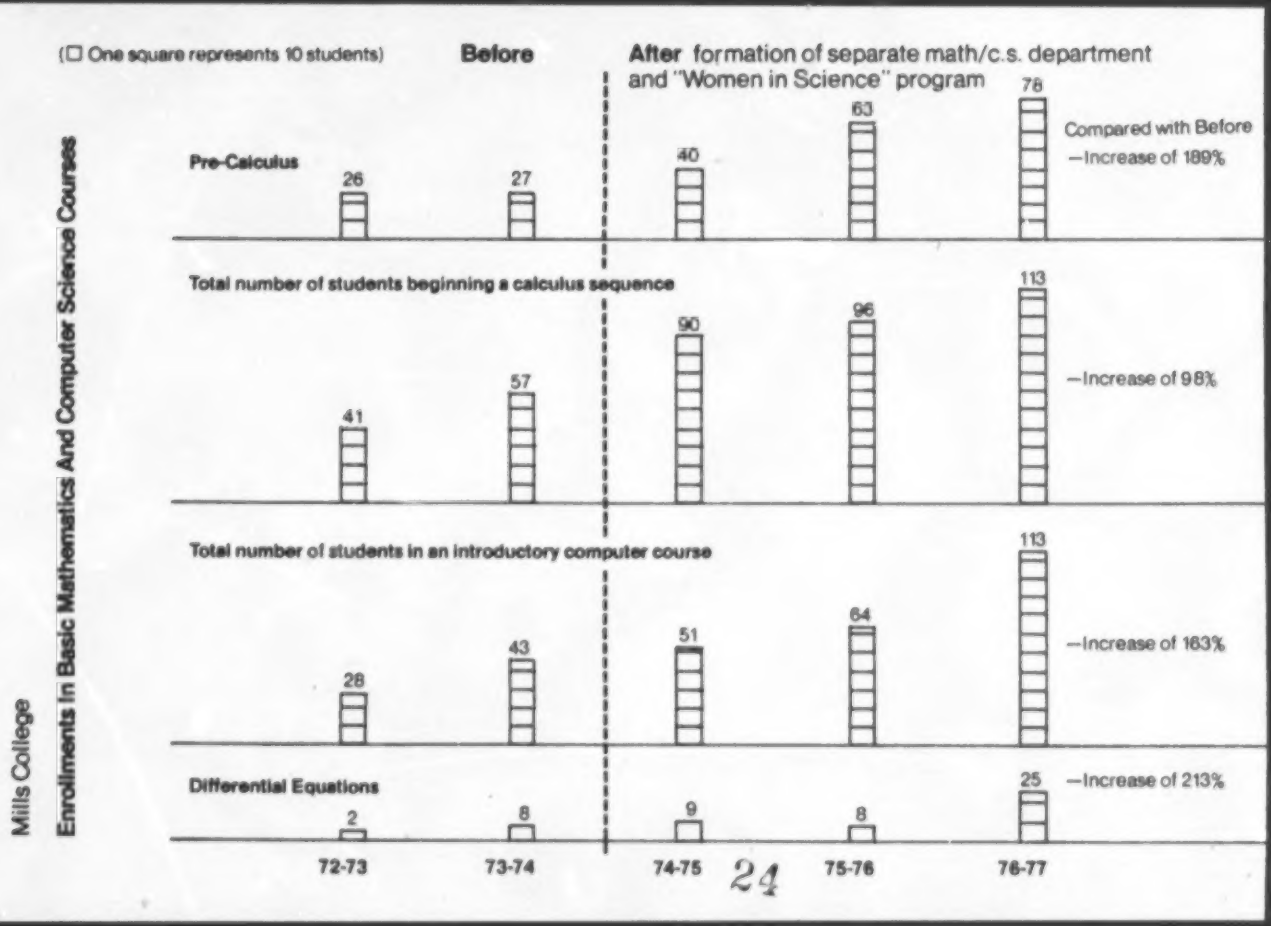
To maintain the momentum of Network efforts, and to strengthen and expand both program and research activities, a Consortium-based Center for Mathematics and Science Education for Women was established in the spring of 1978, funded in part by a grant from the Carnegie Corporation. The Consortium will act as a coordinating agency and research base for projects and studies, and will include a nationwide dissemination program for students, educators, legislators, and the general public. Initial activities of the Consortium will focus on consolidating Network activities. A Consortium resource center and switchboard will be located on the Mills campus. A booklet describing Network activities will be produced. Precollegiate activities of the Consortium (including inservice and preservice programs for teachers, counselors, parents, and administrators) will be based at the Lawrence Hall of Science at the University of California at Berkeley under the direction of Nancy Kreinberg. Collegiate activities, including consulting services, will be based at Mills College under the direction of Lenore Blum.

Mills College

Total Enrollment In Mathematics And Computer Science Courses

Each square represents 10 enrollments
□ In regular classes
| | In Workshops




Mills College
Enrollments In Basic Mathematics And Computer Science Courses
(☐ One square represents 10 students)
Before
After formation of separate math/c.s. department and "Women in Science" program
Pre-Calculus
26
27
40
63
78
Compared with Before —Increase of 189%
Total number of students beginning a calculus sequence
41
57
90
96
113
—Increase of 98%
Total number of students in an introductory computer course
28
43
51
64
113
—Increase of 163%
Differential Equations
2
8
9
8
25
—Increase of 213%
72-73
73-74
74-75
75-76
76-77

Women in Science Program

9:00 a.m. *Pick up registration packets*
Concert Hall

9:30 a.m. *Welcome.* Lenore Blum,
Department of Mathematics and Computer Science,
Mills College.

Keynote speech: 'Does Grey Matter Matter?'
Marian C. Diamond, Professor of Physiology
and Anatomy, University of California, Berkeley.

10:15 a.m. *Roundtable discussion: Careers for Women in the Sciences.*

Moderator: Lenore Blum

Biochemist
Marion E. Smith, Department of Neurology,
Veterans' Administration Hospital, Palo Alto

Computer Scientist
Nancy Martin, Visiting Associate Professor,
Department of Computer Science, Stanford

Industrial Engineer
Wendy Westover, IBM

Mechanical Engineer
Zella M. Jackson, Dow Chemical U.S.A.

Pharmacist
Diana Dimmitt, Director of Pharmacy Services,
Ross General Hospital

11:30 a.m. *Math and Science Workshops*
(see listing next page)
Parent/Teacher Workshop
Facult, Lounge

12:30 p.m. *Lunch.* Founders' Commons

1:30 p.m. *Career Workshops* (see listing)
Parent/Teacher Workshop

2:30 p.m. *Reception.* Student Union

11:30 a.m. *Math and Science Workshops*
(Select one from appropriate grade level;
indicate 1st and 2nd choice.)

Mathematics

1. **How to Draw Tesselations Like M.C. Escher** (7th - 8th grade). Virginia Thompson
2. **Do You Trust Your Eyes? Explore Geometric Shapes and Qualities** (7th - 8th grade). Nancy Weeks
3. **Mathematics and Sex--Myths, Facts, and Recent Studies on Girls and Math** (9th - 10th grade). Dorothy Dow
4. **Measurement, Mathematics, and Me--What Does It All Mean?** (9th - 10th grade). Judith M. Forcada
5. **Ideas in Statistics and How to Lie With Statistics** (11th - 12th grade). Elizabeth L. Scott

Science

6. **Critter Capers--How an Animal Communicates and Avoids Its Enemies** (7th - 8th grade). Kathy Barrett
7. **Plants on the Move--Explore How Seeds are Dispersed** (7th - 8th grade). Lynne C. Carter
8. **Marine Science--Experiments with Sea Water and Marine Organisms** (7th - 8th grade). Karen E. Reynolds

9. **Human Movement–Experiments with Principles of Anatomy and Physiology** (9th - 10th grade). Sandy Gipsman
10. **Earth Science– A Close Look at Rocks and Crystals and a Discussion of Earthquakes and Faults in the East Bay** (9th - 10th grade). Lori Dengler
11. **Microbiology–What do Yeast, Fungi, and Bacteria look like, What do they do, and How do we use them?** (9th - 10th grade). Ann Marie Norberg
12. **Space in Physics–A perspective on the emptiness of space in physics, from the sub atomic to the universe** (11th - 12th grade). Auriol Bonney
13. **Cell Biology–A discussion of techniques, information, and current problems in cell biology** (11th - 12th grade). Ruth Strand

Parent/Teacher Workshop

Representatives from U.C. Berkeley, Mills College, College of Holy Names, Los Medanos Community College and Stanford University will discuss scholarship opportunities and entrance requirements. Women from scientific and technical fields will be available for small-group discussions. Offered at 11:30 and 1:30.

1:30 p.m. *Career Workshops*
(Select one; indicate 1st and 2nd choice.)

1. Biology
Susan Walker Farmer, Hormone Research, University of California, San Francisco
Yolanda Scott George, Cancer Research, Lawrence Livermore Laboratory
Patricia Lindl, Genetics, Lawrence Livermore Laboratory

2. Chemistry
Chrislyn Carson, Plant Pathology, Dow Chemical
Mary Evans, Medical Devices, Dow Chemical
Lorraine M. Kroposki, Agricultural Chemicals, Dow Chemical
Yulan C. Tong, Pharmaceuticals, Dow Chemical

3. Computer Science
Deborah E. Bennett, Applications Programmer, Lawrence Livermore Laboratory
Nancy Storch, Computer Graphics, Lawrence Livermore
Susan D. Norman, Aeronautics Applications, NASA-Ames

4. Engineering
Wendi Brubaker, Electrical Engineer, Hewlett-Packard
Constance Golden, Mechanical Engineer, Lockheed Corp.
Amelia Sue Marshall, Engineering student, Lawrence Berkeley Laboratory
Sandra Slivinsky, Materials Science Engineer, General Electric Company
Marsha Strahl, Aeronautical Engineer, Westinghouse Corp.

5. Medicine
Muriel H. Bagshaw, Research Pediatrician, American Institutes for Research
Kim Langley, Staff Pediatrician, Kaiser Hospital, Richmond
Theodosia M. Welch, Leprosy Research, U.S. Public Health Hospital, San Francisco
Martha Jo Whitehouse, Internal Medicine, University of California, San Francisco

6. Pharmacology
Carol Gonzales, Pharmacology student, NASA-Ames
Martha Harkey, Researcher in Sickle Cell Anemia, University of California, San Francisco
Joan Vernikos-Danellis, Space Pharmacology, NASA-Ames

7. Physics, Statistics, Astronomy
Julia M. Goodfellow, Physicist, Stanford University
Elizabeth L. Scott, Statistician, University of California, Berkeley
Kate Oliver Brooks, Astronomer, Los Medanos College